Eccentric Pump and Method for Operation of said Pump

PATENT CLAIMS

1. Pump (1) with a housing (2), having an inlet (28) and an outlet (29), a drive (5), a fixed cylinder (2) central to a mid-axis (9), a displacer (18), rotating eccentrically within the cylinder (2), a crank drive (13) for the displacer (18), a circumferential sickle-shaped pumping chamber (26) between the cylinder (2) and displacer (18) and a helical sealing element (27, 27', 27", 39) in the pumping chamber (26), **wherein** the pump is embodied as a dry vacuum pump, whereby the displacer (18) circulates in the cylinder (2) without making contact.

2. Pump according to claim 1, **wherein** the smallest distance between displacer (18) and inside cylinder wall does not exceed 1 mm, preferably 0.2 mm.

3. Pump according to claim 1 or 2, **wherein** the cylinder (2) is a component of the pump housing.

4. Pump according to claim 1, 2 or 3, **wherein** the displacer (18) exhibits a hollow space (20).

5. Pump according to claim 4, **wherein** a cooling gas flows through the hollow space (20).

6. Pump according to one of the claims 1 to 5, **wherein** means (21, 45) are provided which prevent turning of the displacer (18) about the axis (9) of the cylinder (2).

7. Pump according to one of the claims 1 to 6, **wherein** means (46, 47) are provided which prevent turning of the sealing element about the axis (9) of the cylinder (2).

8. Pump according to one of the claims 1 to 7, **wherein** the outside wall of the displacer (18) is equipped with a helical groove (30) for the sealing element (27).

9. Pump according to claim 8, **wherein** the helical sealing element (27) has, in the relaxed state, an outside diameter which is greater than the inside is diameter of the cylinder (2).

10. Pump according to one of the claims 1 to 7, **wherein** the inside wall of the cylinder (2) is equipped with a helical groove (30) for the sealing element (27).

11. Pump according to claim 10, **wherein** the helical sealing element (27) in the relaxed state has an inside diameter which is smaller than the outside diameter of the displacer (18).

12. Pump according to one of the claims 8 to 11, **wherein** the sealing element (27) exhibits in the area of the groove (30) approximately radially oriented sealing lips (73, 74).

13. Pump according to one of the claims 8 to 12, **wherein** the sealing element (27) exhibits in the area of its unoccupied face side a substantially axially orientated sealing lip (71).

14. Pump according to one of the claims 8 to 13, **wherein** two or more grooves (30, 30") are provided according to the type of a double or multiple thread as well as a corresponding number of sealing elements (27, 27").

15. Pump according to one of the claims 8 to 14, **wherein** the pitch of the groove (30, 30', 30") from the inlet (28) to the outlet (29) decreases at least section-wise.

16. Pump according to claim 15, **wherein** it is equipped with a relief valve (32) which is located between inlet (28) and outlet (29).

17. Pump according to one of the claims 1 to 16, **wherein** the rotating system (8) with a crank (13) is provided being driven by a drive (5) via a shaft (6), said rotating system with crank supporting the displacer (18) via bearings (16, 17).

18. Pump according to claim 17, **wherein** the rotating system (8) is supported via bearings through two crank sections (14, 15) in bearing pieces (3, 4) on both sides of the pump housing (2).

19. Pump according to claim 17, **wherein** one crank section (14) is cantilevered and where the displacer (18) is supported in a cantilevered manner by the crank section (14).

20. Pump according to claim 17, 18 or 19, **wherein** at least one mass balancing weight (22) is part of the rotating system (8).

21. Pump according to the claims 4 and 20, **wherein** the mass balancing weight (22) is located in the hollow space (20).

22. Pump according to one of the claims 1 to 21, **wherein** it is of a double flow design.

23. Pump according to claim 22, **wherein** it is characterised by a central inlet (28) and outlets (29, 29') located on the face sides.

24. Pump according to one of the above claims, **wherein** it is of a two-stage or multi-stage design.

25. Pump according to claim 19 and 24, **wherein** the displacer (18) substantially has the shape of a double pot[1)] and where in one of the hollow spaces on the face side the bearings (16, 17) of the displacer are located and where are in the other hollow space (36) a second pumping stage is located.

26. Pump according to claim 25, **wherein** a component (35) fixed to the housing and projecting into the hollow space (36) forms with a cylindrical outer surface jointly with the inside wall of the displacer (18) a further pumping stage.

27. Pump according to claim 26, **wherein** a bore (60)[2)] penetrating the component (35) forms the inlet.

28. Pump according to one of the claims 24 to 27, **wherein** the volumes of the pumping chambers in the stage on the intake side are greater than the volumes of the pumping chambers of the pump stage on the delivery side.

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1) **Translator's note:** The German text states "Doppeltropf" here whereas "Doppeltopf" would be more in line with the drawing figures and the remaining text. Therefore the latter has been assumed for the translation.

2) **Translator's note:** The German text states "40" here whereas "60" would be more in line with the drawing figures and the remaining text. Therefore the "60" has been assumed for the translation.

29. Pump according to one of the above claims, **wherein** it is equipped with a gas ballast facility.

30. Pump according to claim 29, **wherein** the housing (2) is equipped with a bore through which ballast gas is supplied via a line (51) equipped with a valve (52).

31. Pump according to the claims 4 and 17 **wherein** the rotating system (8) is equipped with a system of channels (55) through which the hollow space (20) in displacer (18) is connected to the surroundings.

32. Pump according to the claims 29 and 31, **wherein** the displacer (18) is equipped with a bore (57) and where the system of channels (55) serves the purpose of supplying ballast gas.

33. Pump according to claim 31, **wherein** the system of channels (55) serves the purpose of supplying cooling air.

34. Pump according to the claims 4, 22 and 33, **wherein** it is characterised by a direction of the pumping action of the two pump stages from their respective face sides to the joint discharge bore (59) whereby one of the pump stages serves the purpose of removing the cooling air from the hollow space (20) of the displacer (18).

35. Pump according to one of the above claims **wherein** the sealing element consists of a PTFE containing material and the displacer (18) as well as housing (2) consist of an aluminium material.

36. Pump according to one of the above claims, **wherein** rotational speed and eccentricity are so selected that the sliding velocity between the sealing element and the side wall of the related groove is between 1 and 5 m/s, preferably between 3.5 and 5 m/s.

37. Method for operating a pump (1) with a housing (2), having an inlet (28) and an outlet (29), a drive (5), a fixed cylinder (2) central to a mid-axis (9), a displacer (18), rotating eccentrically within the cylinder (2), a crank drive (13) for the displacer (18), a circumferential sickle-shaped pumping chamber (26) between the cylinder (2) and displacer (18) and a helical sealing element (27, 27', 27", 39) in the pumping chamber (26), **wherein** the pump (1) is operated as a vacuum pump, where the pumping chamber (26) is operated free of lubricants and where the crank drive (13) guides the displacer (18) such that it circulates in a non-contact manner within the cylinder (2).

38. Method according to claim 37 **wherein** the pump (1) is operated with inner compression.

39. Method according to claim 37 of 38 with a pump (1) the displacer (18) of which exhibits a hollow space (20) **wherein** a low pressure is maintained in the displacer (18).

40. Method according to claim 37 of 38 with a pump (1) the displacer (18) of which exhibits a hollow space (20), **wherein** cooling air or ballast gas flows through the hollow space (20) of the displacer (18).